Short Communication

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3D Printing 2020- Additive manufacturing applied in parallel architecture machine

David Sebastian Matamoros Buitargo

Department of Mechanic y Mechatronic Engineering, National university of Colombia, Bogota, Colombia

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The following research are focused in take an old router machine and adapt it for ceramic materials additive manufacturing. The lining of it is improve the small or medium industry that by any reason can't get new high-end capabilities machinery but has old machinery that can be improved or repowered adding some other manufacturing technologies.

Following this idea, the laboratory has a parallel CNC router built in 2006 with an unsupported hardware (too old) and software with limited capabilities, the followed document show how is made the 3d ceramic printing capabilities repowered to this machine under single minutes exchange die (SMED) paradigm. Also, will show the software adjustment made and the following calibration of all the variables concerned at this investigation.

This development can also be use in the petrochemistry industry to make ceramic pellets that can be used to oil refinement.

Introduction: The origin of the use of ceramics goes back to ancient Greece, initially created for the creation of pots or plates for food, and based on clay cooked at temperatures of up to 500ºC. Later, around the 19th century, the attributes of these materials were discovered in the industry: mainly as thermal and electrical insulators in motors. Due to its long history, the advent of ceramic 3D printing was to be expected, as ceramic materials have mechanical properties and high-resolution geometries that could not have been possible to exploit with traditional techniques.

A few months ago, during the second report of the firm Smartech Publishing, the latest report on the evolution of ceramic 3D printing was presented. It stated that in 2028 this industry will generate up to $3.6 billion worldwide. Although it is not yet as well established as plastic technologies or even metal additive manufacturing, it has a great future. According to the report, 3D printing of ceramics will reach maturity in 2025 spreading as a manufacturing technique in different industries.

Evolution of a new ceramic technology: Historically, clay has been the most commonly used material when it comes to manufacturing ceramic materials, largely due to the fact that it is a natural material that is easy to find in almost any environment. As the materials have evolved, more manufacturing possibilities have arrived. There are currently different types of ceramics: the most common are those we use in the domestic environment: in crockery, tiles, etc. On the other hand we have structural ceramics, used in construction such as tiles or bricks; refractory ceramics used in cladding; and technical ceramics, materials with great mechanical, thermal, chemical and electrical resistance. This last type does not include clay, and is especially valued in industries such as automotive or aerospace.

Note: This work is partly presented at 3rd international conference on 3dprinting and additive manufacturing (May 22, 2020 Paris, France)

There are currently different methods of 3D printing ceramics, some of the best known are light-curing technologies such as SLA and DLP, Binder Jetting, Deposition of Material (LDM – Liquid Deposition Modeling) and the most recent, Nano Particle Jetting of the Israeli company XJet.

Binder Jetting specialised in ceramic materials: Binder Jetting is one of the technologies that began to manufacture with ceramic powders. The beginnings of the technology go back to the 90s: starting with an MIT project, then acquired by Z Corporation, and after a few years of development bought by 3D Systems. The technique consists of manufacturing ceramic powders using a binder that solidifies in a cross-section on a powder bed. This results in full colour models, although not very resistant for some industrial purposes.

Stereolithography and photopolymerisation of ceramic materials

Other technologies also date back to the advent of additive manufacturing technologies such as sterolithography, although it was not until years later that ceramic materials were incorporated. One of the great pioneers in the ceramic additive manufacturing industry is the French company 3DCeram.

"It was in 2005 that Christophe Chaput decided to investigate the possibility of additive manufacturing combined with ceramics. He started printing biomedical parts, skull implants… In 2009, he and I bought the company Cerampilot and decided to change the name to 3DCeram and change its business model, i.e. to manufacture parts only through 3D printing", commented Richard Gaignon, CEO of 3DCeram, after asking him about the origins of its developments. From 2014, the French company integrated DLP technology by incorporating a UV laser into its machines. They now have a wide range of 3D printers such as the C900, a hybrid press that can print more than one material at the same time, dedicated to the electronics and energy industry. Plus two additional machines launched this year: The C100 a machine "KISS" (Keep It Smart and Simple) according to the manufacturer and its C3600 specialised in technical ceramics.

In addition to the developments of the French company, there are actors such as the giant 3D Systems that offers ceramic resins within their material range. Something that also incorporated the American company specialised in desktop SLA 3D printers, Formlabs. The Dutch company ADMATEC specialises in technical ceramics and manufacturing with DLP technology.

Material Deposition or Liquid Deposition Modeling

The technique of deposition of material or also called LDM (Liquid Deposition Modeling), is the technique that has spread most amongst the different actors. It consists of depositing layers of ceramic material until the piece or model is formed, following the FDM technique but with extruders adapted to the material. This technique is also the least expensive as clay and filler polymers are the main materials.

This technology inspired many manufacturers to create (mainly) desktop machines that have found great success such as the ClayXYZ launched in 2017 or the LUTM V4 that was introduced to the market in 2018 with a more artistic character. One of the most renowned is the Italian company WASP, which offers ceramic 3D printing on a large scale.

NanoParticle Jetting ™

The technique was developed by the Israeli company XJET, thanks to the experience of its CEO Hanan Gothait, whom had founded Objet Geometries, the company behind the Polyjet technology. After years of work and more than 80 patents up his sleeve, in 2016 he launched the NanoParticle Jetting ™, a technology developed for metal and ceramics. Its first solutions were the Carmel 1400 and Carmel 700 AM systems.

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"The key to NanoParticle Jetting ™ begins with its unique liquid dispersion methodology. Liquid suspensions containing solid nanoparticles of selected support and construction materials are injected into the manufacturing tray to additively manufacture detailed parts. The liquid suspensions are delivered and installed in sealed cartridges without problem", Hanan Gothait told us. "The precision of the inkjet printheads plus the use of ultra-thin layers, which create a super sharp Z resolution, enable parts to be extremely and easily neat. This is crucial for 3D-printed ceramics to achieve excellent shape and dimensional tolerance".

Technical and material developments within ceramic 3D printing have continued to grow. A few weeks ago the Japanese group Canon announced its technique for ceramic materials, as well as a material capable of being used with Selective Laser Sintering machines. It is expected that in the coming years more actors will continue to contribute to the evolution of this technology.

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